25X1

MEMORANDUM FOR: [redacted]

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[redacted] gave me the attached note from [redacted] left early today so I had a Xerox copy made for him with a request that he query [redacted] and obtain more information. I also told Bernie that I would not be back in town until 23 Nov. Will you give him a friendly nudge about this?

25X1

[redacted]

P.S. I left the Xerox copy with the secretary in Bernie's area.

25X1

[redacted]

Cable sent 17 Nov 64

24 Nov 64: Called Bernie "No answer". 13 Nov 64
(DATE)

Approved For Release 2005/11/21 : CIA-RDP78B04770A002700030023-6

FORM NO. 101 REPLACES FORM 10-101
1 AUG 54 WHICH MAY BE USED. (47)

SENDER WILL CHECK CLASSIFICATION TOP AND BOTTOM

UNCLASSIFIED	CONFIDENTIAL	✓ SECRET

CENTRAL INTELLIGENCE AGENCY

OFFICIAL ROUTING SLIP

TO	NAME AND ADDRESS	DATE	INITIALS
1	[redacted] P&D		
2	[redacted] closed-circuit TV		
3	[redacted] Commercial [redacted] (for [redacted] ONICS INTEL. (OSI - [redacted])		
4			
5	[redacted]		
6			

X	ACTION		DIRECT REPLY		PREPARE REPLY
	APPROVAL		DISPATCH		RECOMMENDATION
	COMMENT		FILE		RETURN
	CONCURRENCE		INFORMATION		SIGNATURE

Remarks: John — Per my telcon — ACL got a call from a [redacted] OSI who [redacted] or etc) that they are using a piece of equipment (weighs less than 100 lbs & costs less than [redacted] on photo transformations to see increased details — It is a closed circuit TV for enhancing photo images — If [redacted] can't add anything more perhaps [redacted] can get the dope —

Many Thanx

FOLD HERE TO RETURN TO SENDER

FROM: NAME, ADDRESS AND PHONE NO.	DATE
PNS	11-10

UNCLASSIFIED	CONFIDENTIAL	✓ SECRET

FORM NO. 2-61 237 Use previous editions (40)

★ U.S. GOVERNMENT PRINTING OFFICE : 1961 O—587282

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25X1

[redacted] 300-400 line closed circuit television microscope system, shown above, represents significant advances in both television and microscopy. The closely integrated units provide the means by which phenomena otherwise visible to only one microscopist may be shared and simultaneously viewed by an unlimited number of persons. The advantages of group viewing are manifold, particularly when using the phase contrast equipment to observe living specimens. When used to present material to a large assembly, as in the teaching situation, it becomes a valuable supplementary tool. When used for smaller groups, it serves to stimulate the exchange of ideas.

The high resolving power of both the microscope and television system retain all of the detailed, identifying structure of the specimen. The microscope provides optical magnification up to 1,500 diameters, and the electrical magnification (by means of the television equipment and viewing screen), are modified only by size of the monitor, and may be as high as 4,000 diameters.

The microscope, illuminator, TC-110 TV camera and 19" monitor shown, may be purchased for a total of [redacted] 25X1

[redacted] microscope may be used with more sophisticated television systems to increase image clarity and resolving power. Detailed descriptive literature will be provided upon request, and consultation service is always available. 25X1

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25X1 The high resolution [redacted] closed circuit television microscope system produces a crisp, solid picture that does not run the risk of mis-tuning the VHF oscillator in the camera or the tuner in the receiver. It facilitates a common viewpoint for an entire group of students or technicians of an object under microscopic observation. The equipment is easy to work with and
25X1 simple to operate. The entire system in the high resolu-
25X1 tion [redacted] series, completely installed by competent [redacted] industrial television representatives is approxi-
25X1 mately [redacted]

Description of Equipment

TC-100 Television Camera . . .
HR-100 High Resolution Mod. Kit .
Installation Charge of
HR-100, CBL-3 to Camera . . .
CBL-3 Power Cord . . . . . .
CBL-5 Cable with connection 50′ .
TM-1 Tripod . . . .
17″ Conrac Monitor . . . . .
ECT [redacted] rinocular
CCTV microscope . . . . .

[redacted] 25X1

25X1

The [redacted] system displays the image from a microscope on a television screen. Its purpose is to permit an instructor to show to a large number of students subject matter under a microscope quickly and accurately, but inexpensively. [redacted] makes it unnecessary for students to line up and individually look into the instructor's microscope. Nor is it necessary for each student to have his own microscope and individual set of subject materials. The instructor using a television system with his own microscope can be absolutely certain that he and the students are viewing the same subject. He can also point to specific portions of the image during his lecture to improve his explanations. 25X1

The camera used in the [redacted] system is a single unit, self contained camera, powered by 110 Volts AC at 40 watts and produces a picture signal which is routed via a coaxial line to the television picture monitor. The camera and monitor are both capable of 600 lines horizontal resolution to provide pictures with more detail than the best home TV set. The microscope is the [redacted] Model ECTr with the TV "C" mount adapter which screws directly into the lens opening on the camera. The trinocular head permits the instructor to set up the image before he switches it to the camera by movement of the prism in the microscope. A light source and four objectives are included. The camera is mounted with a TM-1 Tripod for additional stability. Any size monitor from 8" to 27" may be used. The 17" monitor is usually recommended as being a practical size and reasonably portable. 25X1 25X1

25X1

Laser-television system developed with off-the-shelf equipment

Signals are transmitted in atmosphere for more than a mile. Inexpensive system may be used for tv link among 11 buildings during the day and night

By C. J. Peters, R. F. Lucy, K. T. Lang, E. L. McGann and G. Ratcliffe

Applied Research Laboratory, Sylvania Electronics Systems Division of Sylvania Electric Products, Inc., Waltham, Mass., a subsidiary of General Telephone & Electronics Corp.

A relatively inexpensive gas laser television system using off-the-shelf equipment has been developed to transmit through the atmosphere during the day or the night.

Excellent picture definition has been achieved in an experiment with the system over a 6,000-foot transmission link. The developer, Sylvania Electric Products, Inc., is considering using the television system to interconnect an 11-building complex in a 12-mile diameter circle in Waltham, Mass.

The key to the laser-tv system is a video modulator developed by Sylvania's Applied Research Laboratory. The type S2A device is electrically and optically similar to a device described at the 1964 Northeast Research and Engineering Meeting[1] in Boston, except that the S2A is not a traveling-wave type of structure. Such a structure isn't required in this system because the bandwidth for the simple video link is relatively narrow. The electro-optic effect on which the S2A depends for its operation is a variation in the index of refraction along a particular axis of the crystal material used, in response to an electric field, in this case the applied video signal.

Previous attempts

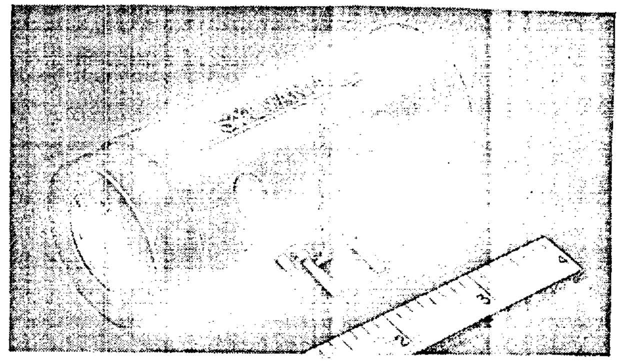
The laser-tv experiment over the 6,000-foot link is not the first time that a tv signal was imposed on a laser beam. S.M. Stone and L.R. Bloom[2] at the laboratories of Sylvania's parent company, the General Telephone & Electronics Corp., demonstrated transmission and detection of a three-gigacycle microwave subcarrier superimposed on a laser beam to carry tv and audio modulation.

Nor is it the first time such a signal has been received[3] over an atmospheric path. However, it is the first time that television has been transmitted over a long path using a small laser system constructed of readily available components.

In the first step of the tv-laser experiment, the laser link was operated over a path that included a mirror and a remote receiver. The mirror was used to achieve a long path and to show that the laser beam could be successfully reflected at an angle.

A retroreflector—similar to a radar corner-reflector—comprising three mirrors mutually intersecting at right angles, was used in the final experiment so that the sending and receiving terminals were at the same place to simplify evaluation of the received picture.

The television signal is imposed on the beam from the laser in the form of video amplitude modulation as shown in the diagram on page 77. The signal is obtained from one of the video stages of a television receiver, amplified by a commercial



Coherent-light optical modulator is inserted between laser beam source and output of the laser transmitter. Modulation is usually limited to 30%, requiring an applied voltage of 110 volts.

Table of experimental details

Laser wavelength	6,328 angstroms
Laser output power	500 microwatts
Transmitted beam width	½ milliradian
Retroreflector diameter	2½ inches
Effective receiver aperture	5 inches
Receiver optical filter	50 angstroms
Photomultiplier type	7265
Modulation	a-m
Transmitter optics	none

video amplifier and placed on the laser beam using the S2A video modulator shown on page 75.

At the receiver, the signal is collected with inexpensive optical equipment, passed through a narrow-band optical filter and field stop and detected by a photomultiplier. Two simple devices, the narrow-band filter and the field stop, are essential for daytime operation. The output from the photomultiplier after video amplification is injected into the picture tube of a second television receiver. Comparison of the pictures is on page 77. The excellent definition of the laser-transmitted picture indicates good transient response of the modulator and associated electronic circuits. The lack of "snow" indicates a qualitative idea of the good signal-to-noise performance of the system. Part of the noise results from the laser and part from the intense daylight background. The relative noise contributions from these two sources is not known precisely, but it is expected that the laser noise will be negligible in a final system design. A comparatively wideband optical filter (50 angstroms) is used in this receiver. If necessary, daylight discrimination can be improved substantially with a narrower band optical filter.

Effects of weather

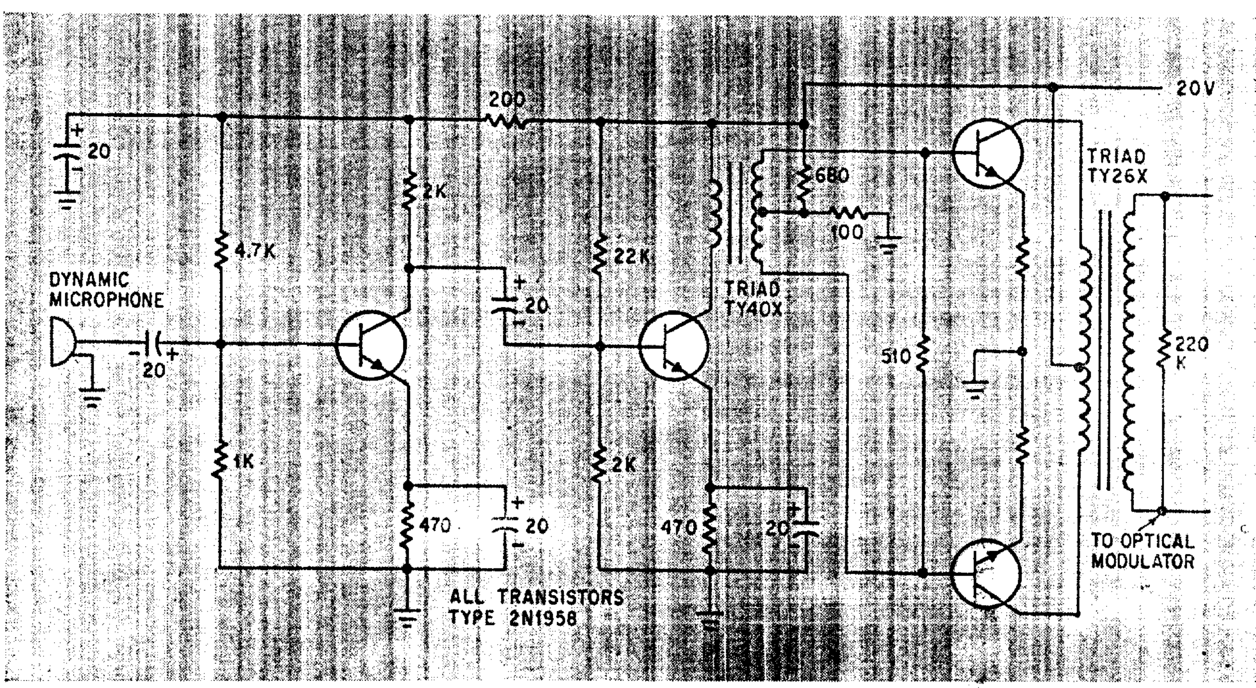
Fog and rain, of course, attenuate transmission over the system. But records of visibility in the area where the system may be constructed indicate that it can operate more than 98% of the time. Such performance is acceptable for the purposes envisioned—interplant conferences during the day and surveillance at gates after dark.

Optical systems also appear attractive for reentry communications applications and for transmitting vast amounts of data within a short period between an orbiting satellite and the earth. Although the transmitter portion is now available, it seems likely that an optical superheterodyne receiver will be needed to cope with intense background light encountered in both these applications.

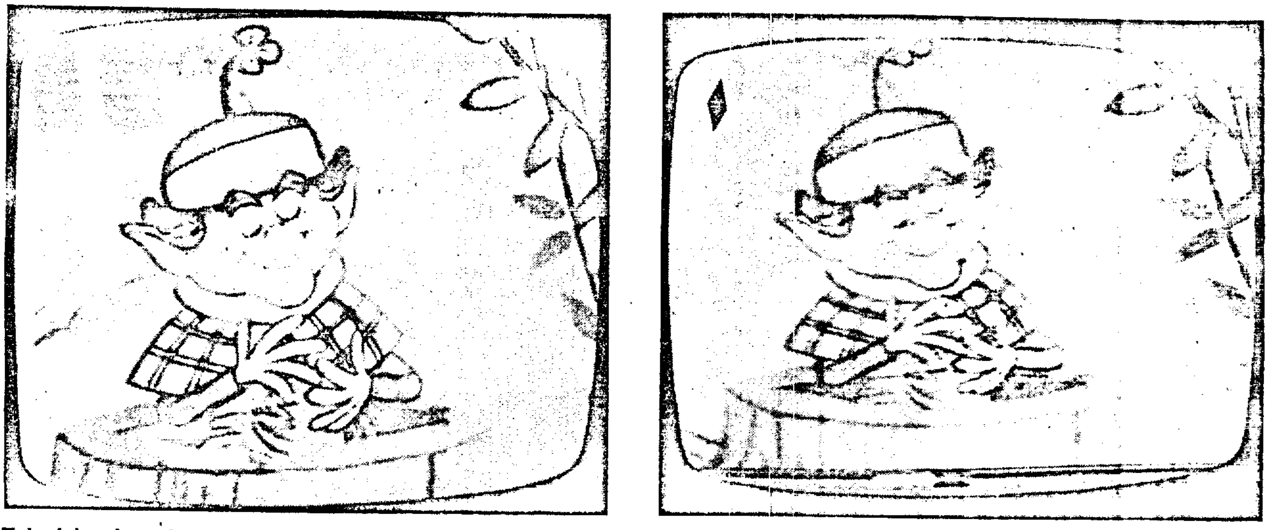
A satellite's battery power can be conserved by using pulse-code modulation for the tv transmission. This digital approach requires a more elaborate system than the analog system described here. However, it is justified when prime power is at a premium. Polarization modulation of the laser beam should be used in the pcm system to get increased range and to reduce atmospheric effects. A model S2P modulator would be used for the polarization modulation. The S2P is electrically identical to the S2A.

Amplitude modulator

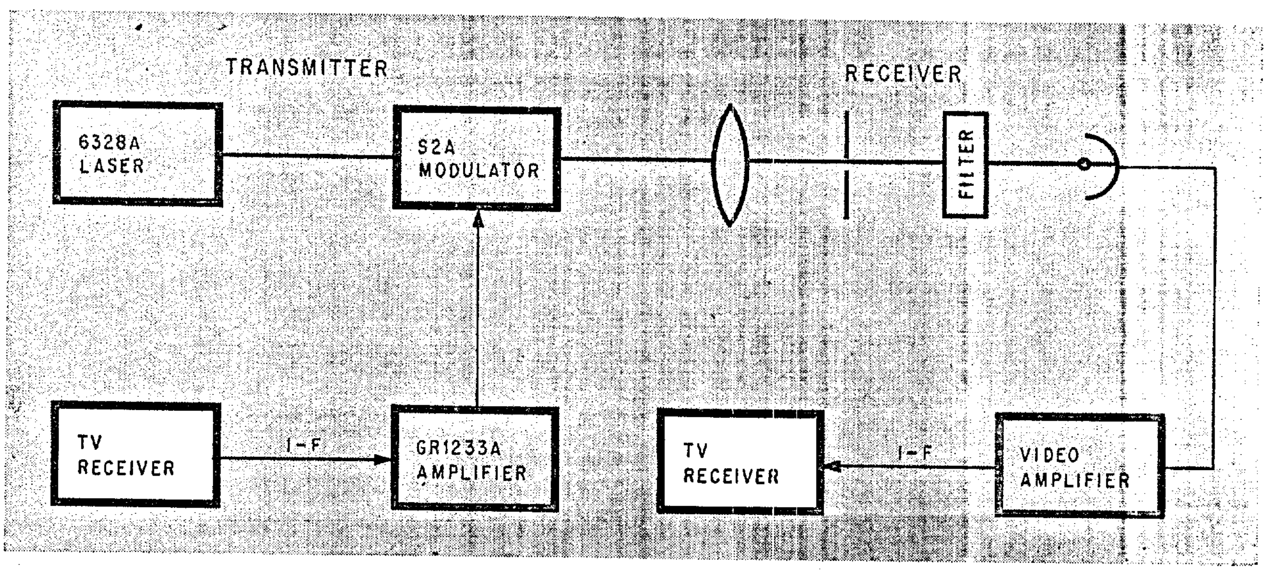
The new amplitude modulator requires comparatively small drive voltages. Previously a Pockels cell, in which the modulation voltage is applied to an electro-optic crystal along the direction of the light travel, was used for amplitude modulation.



Audio driver circuit illustrates simplicity of equipment needed to actuate the optical modulator for a laser-television system.



Television broadcast picture used for test is shown on the screen at the left. The picture received through the laser system is displayed at the right, showing that, despite deterioration, resolution is adequate and noise low.



Experimental laser-television link uses home tv receivers as inexpensive input and output devices. The entire system contains off-the-shelf equipment.

It is difficult to generate the kilovolt signals at video bandwidths to drive the Pockels cell and to dissipate the heat generated within the cell as a result of the high voltage. The S2A modulator requires approximately a 10th the voltage of the Pockels cell, so the power levels are reduced by 100.

The active element in this modulator is KDP (potassium dihydrogen phosphate), which has good optical transmission from about 0.2 to 1.5 microns. However, as is usual in optical modulators, this one contains a quarter-wave plate and other wavelength-sensitive optical elements so that any one modulator is at its peak performance over a comparatively narrow wavelength interval of perhaps 1,000 angstroms.

Since the drive voltage needed to produce a given level of modulation increases proportionately with the optical aperture, a small aperture is desirable. The output beam from a gas laser can easily be collimated to a diameter of about 1 mm (0.04 inch). The modulator aperture of 0.1 inch was chosen to provide a generous tolerance on alignment and centering of the modulator and to accommodate the spreading of the beam caused by diffraction. For ruggedness, the modulator is contained in an aluminum body 1.5 inches in diameter and 3.5 inches long.

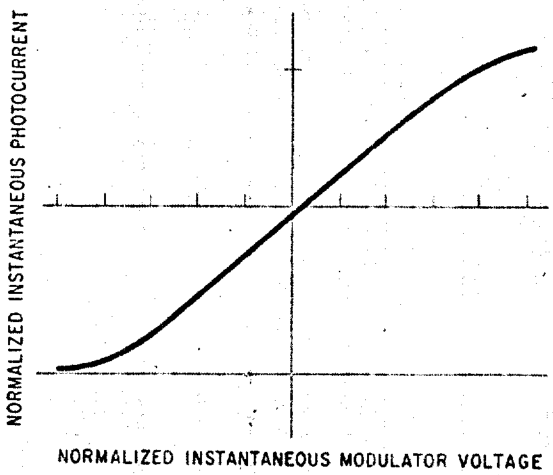
The operating characteristics of the modulator can be described in terms of the circuits required to drive it for various applications. The factor of 100 reduction in drive power mentioned earlier is best illustrated by the simplicity of the audio driver circuit on page 76. The input power to this circuit is approximately 50 milliamperes at 18 volts. The only novel feature of the circuit design is its step-up output transformer that produces approximately 300 volts peak to peak.

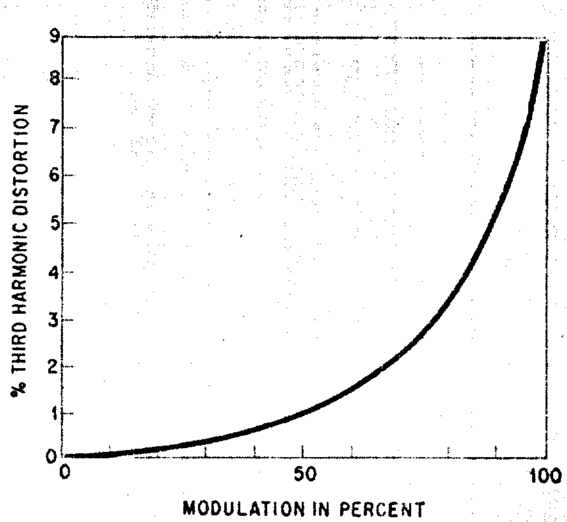
Optical radars sometimes use a sinusoidal amplitude modulation of the light beam to measure range. For accuracy, this modulation frequency is chosen to be as high as possible. Because the KDP crystal has low loss, the 20-picofarad input capacitance of the modulator can be resonated with an inductance at frequencies up to at least 30 megacycles to obtain high-frequency operation at low power.

Such a modulator is ideally suited to pulse-modulation applications, because its frequency response extends down to zero. There is no definite limitation on the upper frequency response. For high duty cycle applications, the bandwidth of this modulator is determined by the internal heating of the crystal. Except for this factor, pulse response equivalent to a bandwidth of 200 megacycles should be realized at a low duty cycle. The time constant of the modulator in parallel with a 200-ohm impedance, which is equal to the output impedance of a Hewlett-Packard 460BR wide-bandwidth amplifier, works out to a value of approximately 4 nanoseconds.

Although this modulator uses KDP crystals in an unusual orientation to reduce modulation voltage, the modulator and the Pockels cell have a similar nonlinear relationship between modulation voltage and light intensity. A photomultiplier, when used as a power detector, is also a nonlinear device and to a certain extent these two nonlinearities compensate each other.

The relationship between the instantaneous voltage applied to the modulator and the instantaneous current out of the photomultiplier is shown in the diagram below. The slight curvature of this transfer function produces harmonic distortion in the photomultiplier current. The magnitude of the third-harmonic distortion as a function of the depth of modulation[4] is shown in the lower curve. The third-harmonic distortion, as shown, is negligible below 75% amplitude modulation.





Amplitude-modulator and phototube system produces a transfer function (above) that relates photomultiplier output current to modulator input voltage. Third-harmonic distortion (lower curve) is not appreciable until depth of modulation exceeds 75%.

References

1. C.J. Peters, "Traveling Wave Amplitude Modulator," NEREM Record, Nov., 1964, p. 70.
2. Samuel Weber, "Laser beam carries tv video and audio," Electronics, Feb. 22, 1963, p. 28.
3. R.J. Keyes, T.M. Quist, R.H. Rediker, M.J. Hudson, C.R. Grant and J.W. Meyer, "Now out of the lab: modulated infrared diode," Electronics, Apr. 5, 1963, p. 38.
4. B.H. Billings, "The Electro-Optic Effect in Uniaxial Crystals of the Type XH_2PO_4, II. Experimental," Journ. Opt. Soc., Oct. 1949, p. 802.

The authors

Charles J. Peters, developer of the wideband laser modulator and senior scientist at Applied Research Laboratory, received his Ph.D. in electrical engineering from the Carnegie Institute of Technology. Before joining Sylvania in 1957, he worked on missile countermeasures.

Gerard Ratcliffe has recently been in charge of the physical design of many components used in the laser research program, including special optical benches, electro-optical modulators and high-precision nonmicrophonic mirror mounts.

Kenneth T. Lang has worked on electromechanical devices for automatic frequency control of lasers in an optical superheterodyne and on a laser doppler shift experiment using a rotating target mirror. He has also worked on a precision optical tracker.

Edward L. McGann is participating in the design and development of an optical superheterodyne receiver, a laser tracking system and optical modulators. He was previously engaged in radiolocation work, countermeasures techniques and the development of specialized uhf filters.

Robert F. Lucy has designed and constructed a special microwave phototube for laser systems and has designed numerous laser experiments, including the optical beating of two gas lasers, doppler shift and atmospheric propagation. He is author of a previous article for Electronics on crystal switches for radar use.

"CCTV Planning", Mayer & Chipp.

P 206.

"21 inch TV picture tube ... spot size 0.025" to 0.030" in dia."

40 to 33 TV lines per inch

P4 phosphor, white, medium persistence (0.005 sec)

P11 " , blue, (photo use)

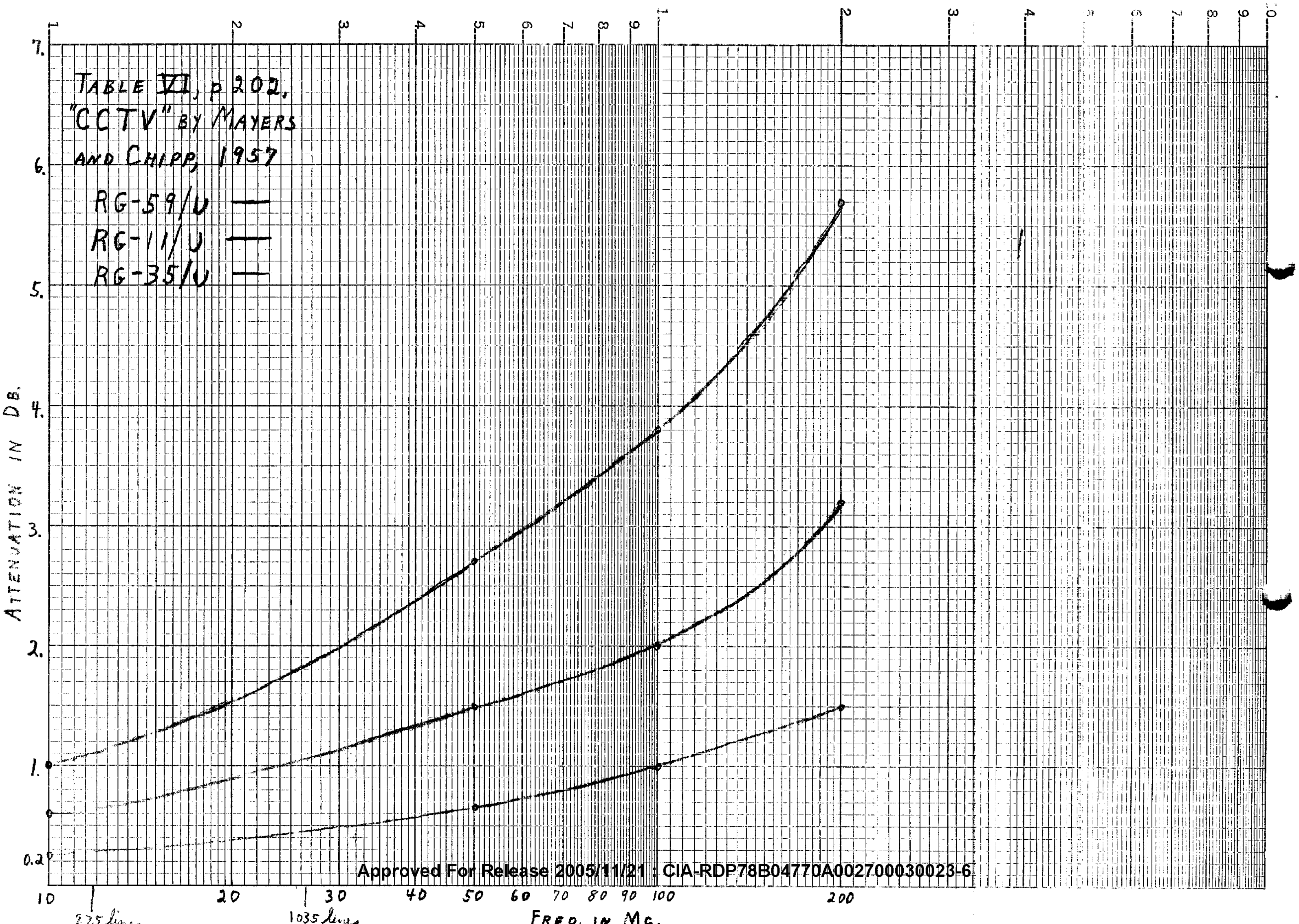
P7 " , long persistence (3.5 second)

radar & slow-scan TV

Equipment cost data from p 235, "CCTV Systems Planning" by Mayers & Chipp. (1957)

25X1

3 ea	Industrial camera
	Broadcast vidicon camera
	Extra single chain cameras (broadcast?)
1 ea	Video switcher fader
2 ea	Video amplifier
200 ft	Camera cable
1000 ft	Remote cable
6 ea	Monitor 1 per camera, 2 [illegible], 3 [illegible]
	Projector (video)
1 ea	Remote pan & tilt
1 ea	" lens change
1 ea	" control iris, focus
1 ea	Light weight tripod
1 ea	Light box for test chart
1 ea	Oscilloscope
4000 ft	Coax RG/11-U



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		Flying Spot Scanner			
1	Cost of pickup tube usage? P220				
	Page 146 ¶ 4				
a	Sensitivity, light S/N ratio				
b.	Resolution		300 lines	600 lines at ctr	600 lines at ctr
c	Spectral response		Includes visible spectrum	Includes visible spectrum	Includes complete visible spectrum
d	Persistence (lag-time)				
e	Dynamic range				
f	Spurious signals				
g	Image size		2.5" diagonal, req. larger lenses than for 35 mm	0.62" diagonal, use lenses dev. for 16 mm	1.6" diagonal, use lenses dev. for 35 mm film
h	Max. light w/o injury				
i	Temp. range w/o injury		0°F - 150°F	77°F - 99°F	95°F - 140°F
j	Ability to operate under conditions of shock & vibration				

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		FSS	[redacted]		
k	Complexity of adj.				
l	Life		1 year guaranty Sometimes 10 years	500 hrs warranty Sometimes 5-10,000 hrs	500 hrs warranty 600-700 hrs common 25X1
m	Cost		[redacted]		
	Power supply reqmnts		-2,300 V	-100 V Control grid +300 V Other electrodes & ext coils 6.3 V for heaters	1500 V for mult -500 V for [illegible] +330 V for scanning, ext. coils, etc 6.3 V for heaters

Page 220. "A rough estimate of annual maintenance expense is 30% of the small receiving type tubes per year, plus the cost of the pickup tube usage

Recent Developments of Electronic Special Effects in Television

By ULRICH MESSERSCHMID

Two novel methods provide ways of producing electronic special effects in television. By superposing suitably modulated signals on the deflection currents, e.g., on those of a TV camera, it is possible to modify the geometry of the picture and to obtain a multitude of different effects, which, for example, may be used in entertainment productions. By means of an additional modulation, the sinusoidal or pulse-shaped alterations of geometry can be moved, for instance, in the rhythm of a piece of music. By differentiating and shaping the video signal of a normal television picture, outline pictures containing only the edged structures can be produced. In order to obtain the horizontal parts of the outlines, it is necessary to differentiate in the vertical direction by means of an ultrasonic quartz delay line.

In the fields of sound broadcasting and disc production, the possibilities of influencing the sound signal after it is recorded have been used for interesting effects for many years. Most studios have had special effects units for processing the sound signals for a long time. It is an obvious step to use TV techniques for influencing the picture electronically in quite a similar manner. In the Institut für Rundfunktechnik several investigations have been carried out in recent years that resulted in the development of two methods, "raster modulation" and "electronic outlining," which are described here.

Presented on October 18, 1963, at the Society's Technical Conference in Boston by Ulrich Messerschmid, Institut für Rundfunktechnik GmbH, 60 Florianmühlstr., München-Freimann, Germany, and first published in *Rundfunktechnische Mitteilungen, 3:* pp. 160–171 and 172–180, 1963.

Most of the engravings of this paper were provided through the courtesy of *Rundfunktechnische Mitteilungen.*

(This paper was first received on August 19, 1963, and in final form on March 12, 1964.)

RASTER MODULATION

It is well known that the geometry of a television picture is mainly determined by the rasters, which are written when the picture is taken and when it is reproduced. If suitable signals are superposed on the deflection currents, for instance on those of a TV camera, it is possible to modify the geometry in a specified manner and to obtain thereby a multitude of different effects, which, for example, may be used in entertainment productions, with amazing results.[1]

In order to provide the largest possible number of different effects, the geometry must be variable both in the horizontal and in the vertical direction. Moreover, it must be possible to modulate the position as well as the size of the raster in these two directions in many different manners. In the simplest cases, sinusoidal signals are used for these purposes.

Stationary Sinusoidal Modulations: Figures 1 and 2 show sinusoidal modulations. For the modulation in the horizontal direction a 50-cps sine wave is superimposed on the 15-kc/sec deflection sawtooth-current either by addition (Fig. 1, top) or by multiplication (Fig. 1, bottom).* Correspondingly a 15-kc/sec sine wave is used for the modulation in the vertical direction (Fig. 2). Figure 3 shows an example of modulation of position. In contrast to modulation in the horizontal direction, modulation of size cannot be effected by simple multiplication only: the 15-kc/sec sine wave must be multiplied by a 50-cps sawtooth before it is added to the 50-cps deflection-sawtooth (Fig. 2, bottom). The deformation then disappears in the middle of the picture and has its opposite peak values at the borders, due to the multiplication.

Instead of 15-kc/sec or 50-cps sine waves, the multiples may also be used. Thereby, a correspondingly larger number of waves is obtained in the TV picture (Fig. 4). It is important only that all these sine waves are exactly locked with the synchronizing pulse generator, because this is the only way of achieving stationary modulations. Inasmuch as it is impossible to obtain such a high stability of

* All the figures given in this article are based on the 625-lines standard.

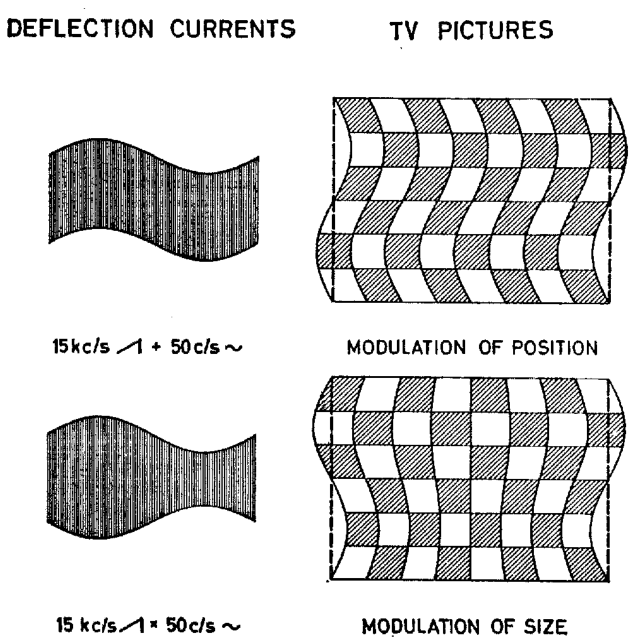


Fig. 1. Sinusoidal modulation in the horizontal direction.

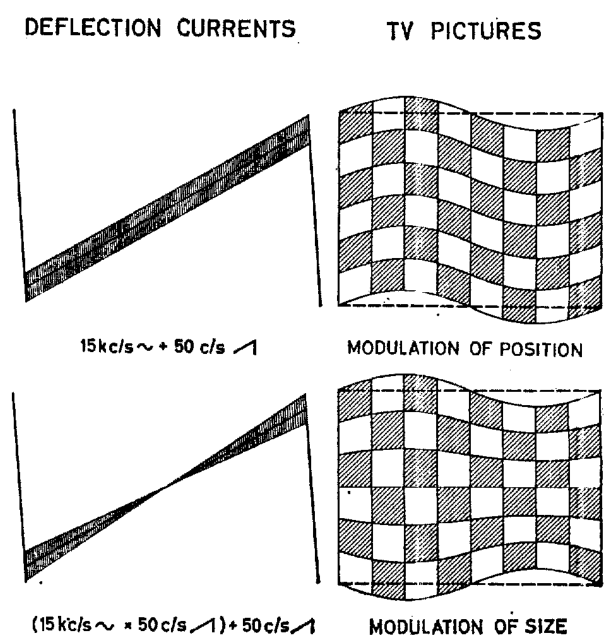


Fig. 2. Sinusoidal modulation in the vertical direction.

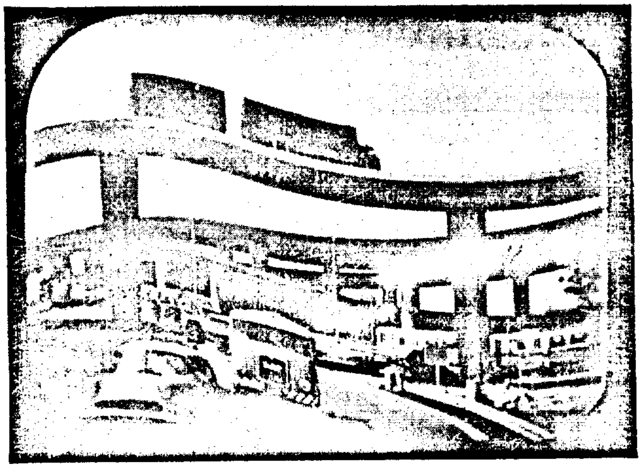


Fig. 3. Sinusoidal modulation of position in the vertical direction with modulating frequency of 15 kc/sec.

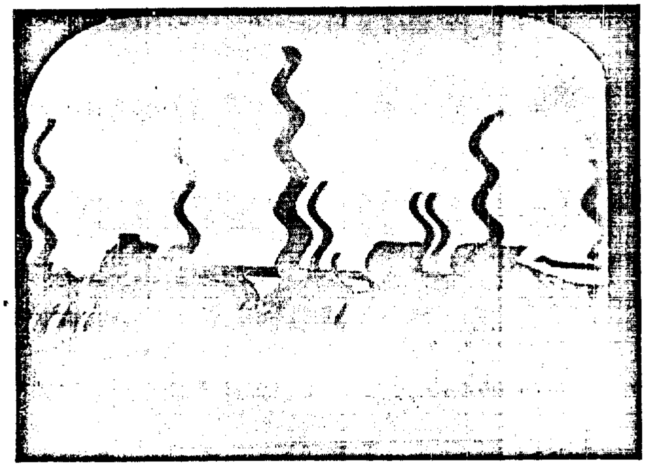


Fig. 4. Sinusoidal modulation of position in the horizontal direction with modulating frequency of 400 cps.

frequency with a variable-frequency generator, the modulating waves were derived directly from the V-drive and H-drive pulses.

Moving Sinusoidal Modulations: Besides the stationary alterations described above, it is also possible to generate modulations showing a slow, sinuous motion. For this purpose frequencies are needed which deviate to a small adjustable amount Δt from the frequency of the synchronizing pulse generator. There are no particular difficulties in generating this frequency (50 cps $\pm \Delta f$) for the modulation in the horizontal direction. On the other hand, for the modulation in the vertical direction a special circuit has been developed, which by means of two single-sideband modulators generates the adjustable frequency 15 kc $\pm \Delta f$ out of the H-drive pulses.[1]

Pulse-Shaped Modulations: The most versatile applications are provided by pulse-shaped modulating signals because by means of them it is possible to direct the alterations to special parts of the picture while the other parts remain unchanged. Position, width and rise time of the pulses can be adapted to specific requirements. In this case, too, modulations of position as well as of size are possible in both directions. Figure 5 shows an example of modulation of position in the vertical direction.

Additional Modulations With Low Frequencies: In addition to the methods noted above, the signals used for changing the geometry can also be modulated by any low-frequency voltage in the 0.5- to 3-cps range. This additional modulation causes slow changes in the amplitude of the alteration originally selected and is therefore restricted to those parts of the raster that are affected by the original alteration. Thereby it is possible to change the geometry of the picture, e.g., according to the rhythm of a given piece of music.

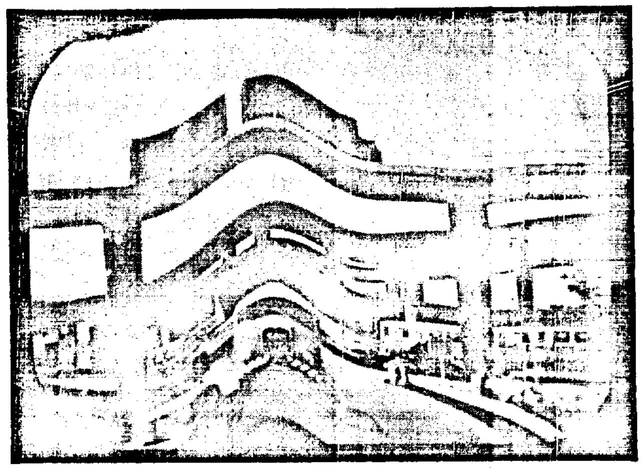


Fig. 5. Pulse-shaped modulation of position in the vertical direction.

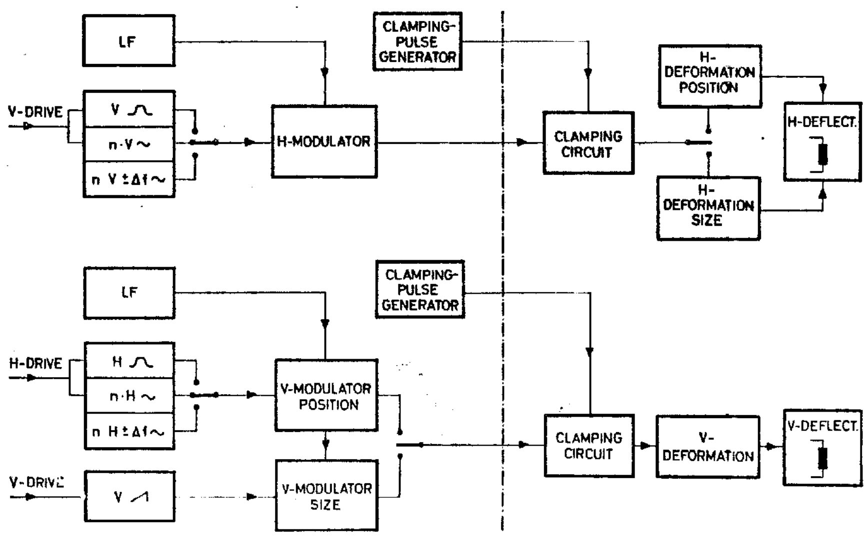


Fig. 6. Block diagram of equipment.

The Equipment

Two different versions of the equipment were developed. The version built at first works with a normal vidicon camera, the deflection circuits of which were modified so that they could be fed with modulating signals. For the most versatile application of the device, a second version was developed, that permits the signals of any picture source to be modulated subsequently as mentioned above. At the present stage of technical development, this is only possible indirectly by going back to an opti-

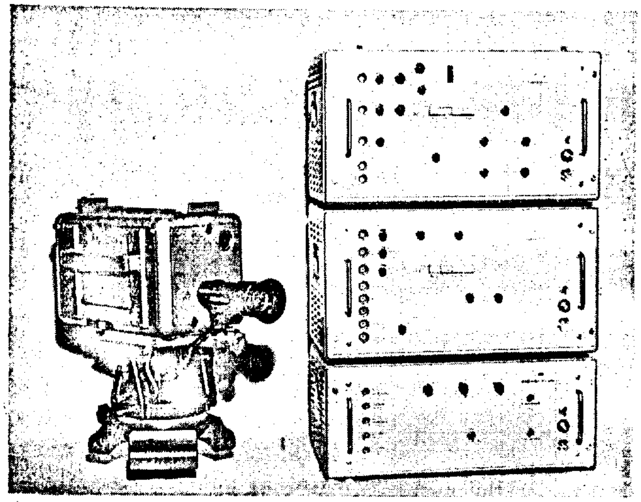


Fig. 7. Equipment for raster modulation.

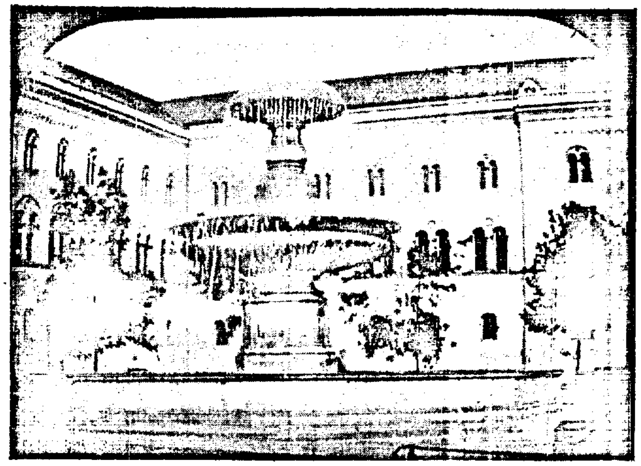


Fig. 8a. Original picture.

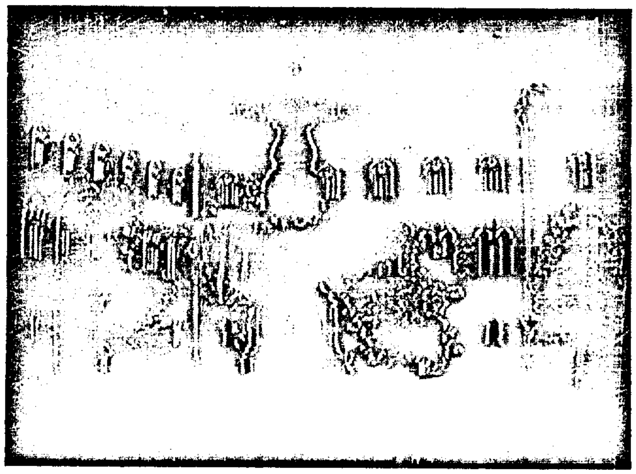


Fig. 8b. Differentiation in the horizontal direction.

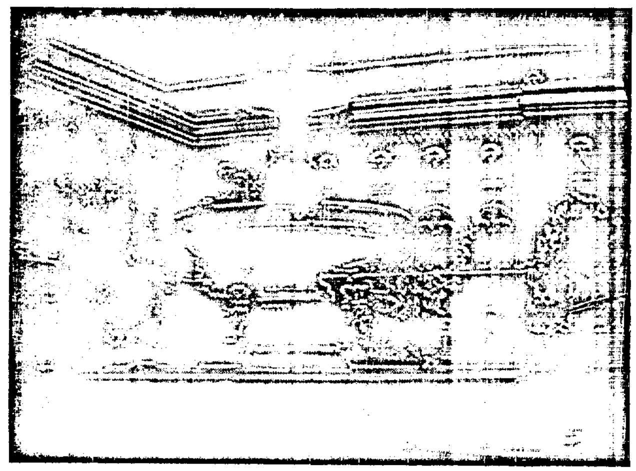


Fig. 8c. Differentiation in the vertical direction.

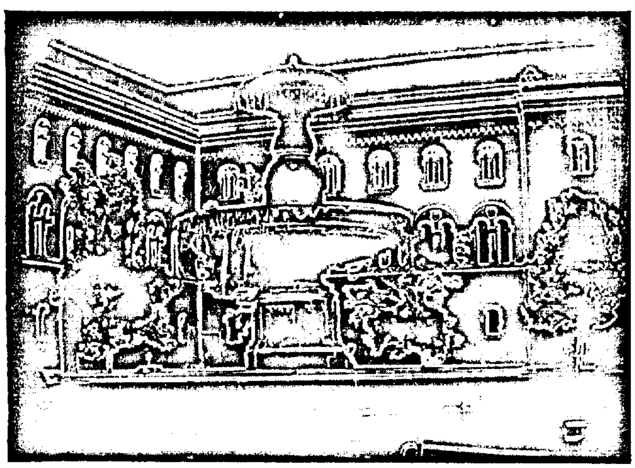


Fig. 8d. All-direction outline picture.

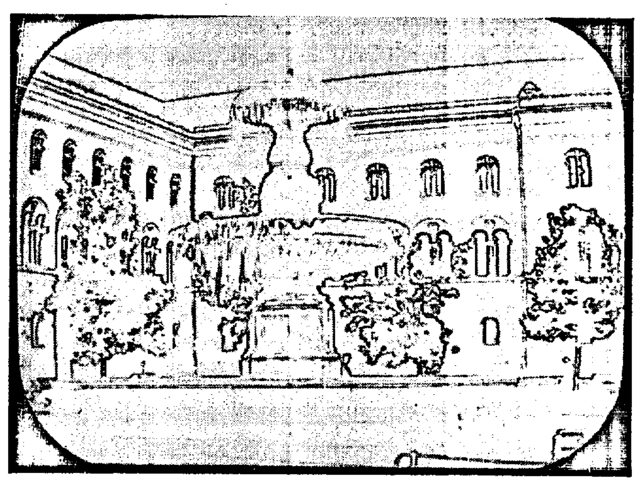
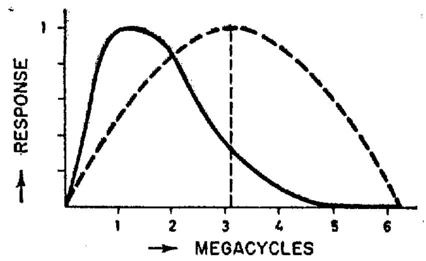


Fig. 8e. All-direction outline picture with reversed polarity.

Fig. 8. Process of obtaining the all-directional outline picture.

cal picture and photographing it with a TV camera once more. This version is therefore called a "special effects converter" because it is built up very much like a standards converter. In this case the raster of the kinescope is modulated and picked up once more by a Plumbicon camera. This method gave good results; further details may be found in the reference cited.[2]

In the block diagram of Fig. 6 a survey is given of the different parts of the equipment. On the left the signal generators for the different kinds of alteration are shown. For additional modulation with low frequencies and for realizing the alteration of size in the vertical direction all three modulators are needed. On the right of the diagram the signals are fed to the deflection coils after they have passed two clamping circuits, by means of which the unchanged parts of the pulsed alterations are held fast. Finally, Fig. 7 gives an impression of the dimen-



- - - - Δt = 160 ns
——with additional 200-ns-Thomson-filter.

Fig. 9. Frequency responses for differentiation.

sions of the whole equipment when using a vidicon camera.

THE ELECTRONIC PRODUCTION OF OUTLINE PICTURES

The purpose of the second method was to produce outline pictures out of normal television pictures by shaping the video signal. For that reason the gray tints have to be suppressed while the edged structures are emphasized. This is done by comparing adjacent picture elements or, in other words, by differentiation. Since the television picture has two dimensions, it is necessary to differentiate in the horizontal as well as in the vertical direction. Consequently, the method works with the separate H- and V-channels.[3,4]

Out of a normal TV picture (Fig. 8a) by means of differentiation and some shaping processes a picture is obtained that contains only the vertical outlines (Fig. 8b). In a corresponding way, the picture shown in Fig. 8c is produced in the other channel. By adding these two pictures the composite, all-directional outline picture is obtained (Figs. 8d and 8e). Compared with the original picture, the outline picture looks very much like a drawing; this is an especially interesting effect if there is motion in the picture. In order to produce the most complete outlines and to prevent the noise present in the original picture from becoming disturbingly visible in the outline picture, it is important to select the appropriate mode of differentiation.

Selection of the Appropriate Mode of Differentiation

Differentiation in the Horizontal Direction: Each differentiation may be considered as a subtraction of signals that are shifted in phase by the small amount of Δt. Some thorough experiments with different values of Δt for the first and for the second derivation have shown that to gain a good optical impression of the outlines with a minimum of noise, the best results are obtained with the first derivation and a rather large Δt of about 160 nanosec. The dotted curve in Fig. 9 shows the sinusoidal frequency response that results in this case. Additionally the signal-to-noise ratio can be very effectively improved by lowering the high frequencies before the differentiation by means of a Thomson filter for a risetime of 200 nanosec (Fig. 9, solid curve).

Because most of the important edges of a picture mainly contain frequencies below 2 mc the outlines are not noticeably affected by this measure. This choice of the differentiation leads also to another advantage: because the outlines become somewhat broader and contain less high frequencies, even a smaller bandwidth in the transmitters and receivers will be sufficient for the transmission. In order to produce at all edges outlines of the same polarity, the signal is subsequently push-pull rectified (Fig. 10).

Differentiation in the Vertical Direction: From the practical point of view, the differentiation in the vertical direction that is needed for the production of the horizontal outlines is more complicated than the differentiation in the horizontal direction. For this purpose the adjacent picture elements in the vertical direction

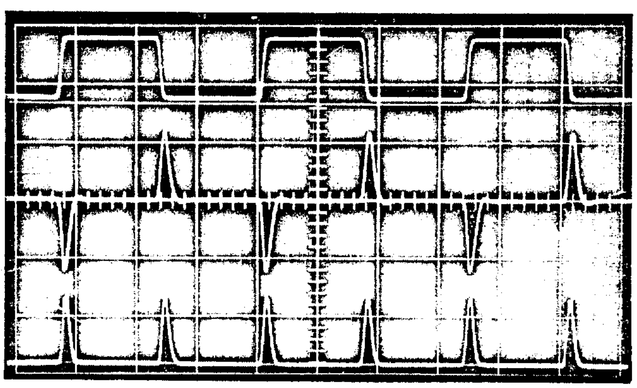


Fig. 10. Differentiation and push-pull rectification for a 250 kc/sec square wave.

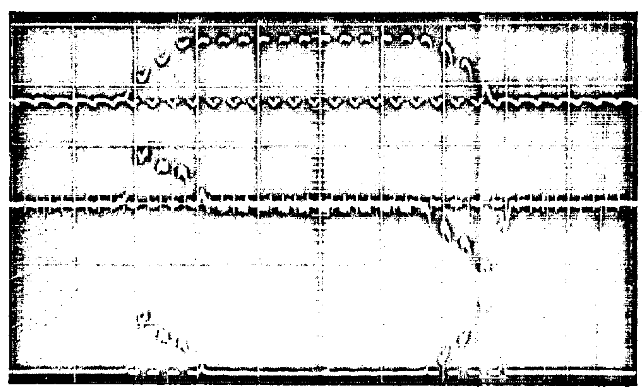


Fig. 11. Differentiation and push-pull rectification in the vertical direction. Original picture was a narrow white vertical bar.

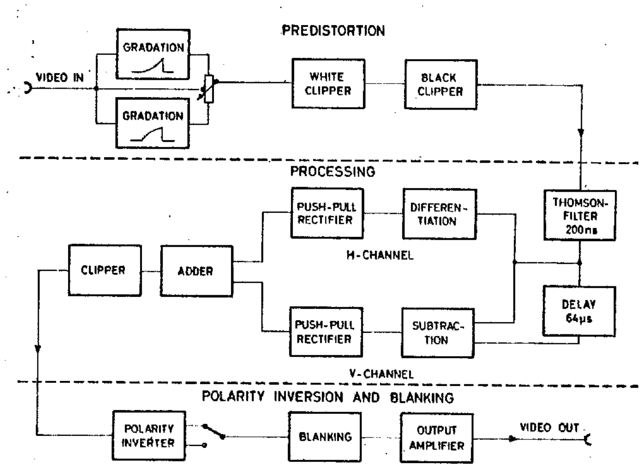


Fig. 12. Block diagram of the electronic outliner.

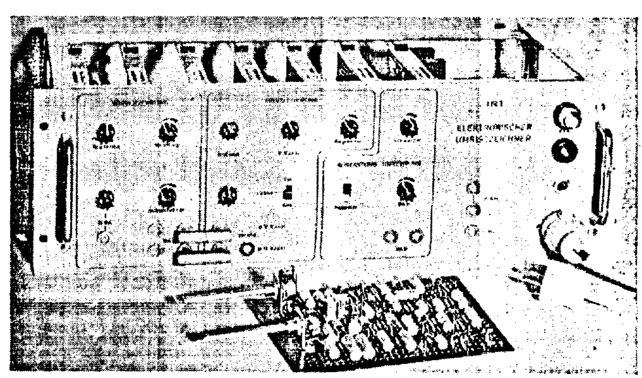


Fig. 13. View of equipment, with a plug-in board in foreground.

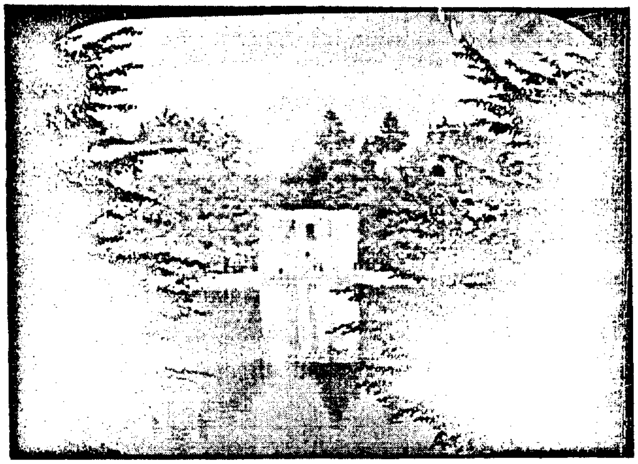


Fig. 14. a) Original picture.

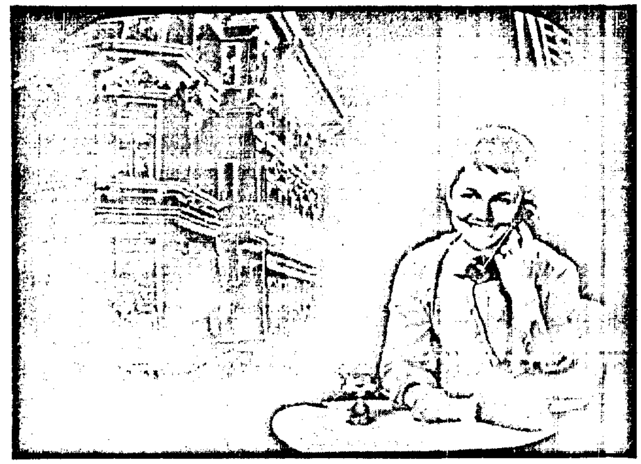


Fig. 15. Combination of an outline picture with a normal second picture.

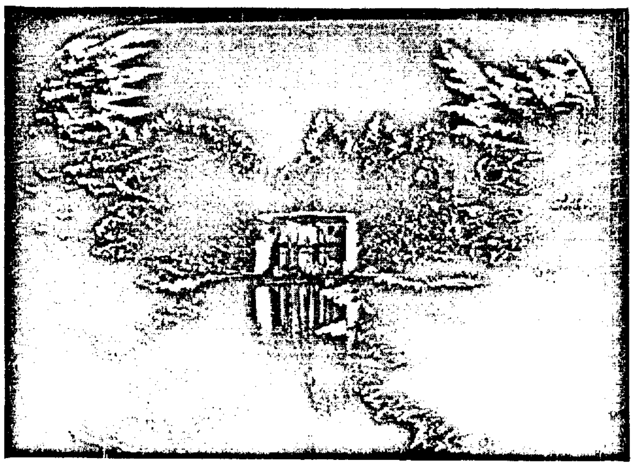


Fig. 14. b) Outline picture.

must be compared, which entails a subtraction of adjacent lines. This can only be done by means of delaying the video signal by one line period, i.e., by 64 μsec. A delay time in this range with a bandwidth of more than 1 mc can only be realized by means of ultrasonic delay lines.

For the production of the horizontal outlines only a restricted bandwidth (1.5 mc at −3db) is needed as several experiments with many different pictures have shown. This makes the construction of the delay line simpler. Nevertheless, even with the smaller bandwidth frequency heterodyning cannot be avoided, because quartz delay lines — the most suitable ones for this purpose — like all supersonic delay lines, are not able to transmit low frequencies directly. In this case, too, the signal-to-noise ratio in the outline picture is improved by the reduction of bandwidth. Figure 11 illustrates by means of a white horizontal bar of 15 lines width the process of differentiating and the push-pull rectification that is needed.

Structure of the Equipment

In Fig. 12 a survey is given of the different functional parts of the equipment. The part named "predistortion" contains some gradation and clipping circuits that may be considerably useful for some kinds of pictures. Subsequently for both channels of differentiation the high frequences are depressed by a common Thomson filter: this is the most effective measure for improving the signal-to-noise ratio. In order to obtain uniform output levels after the addition of the two channels the signal is clipped once more.

In the last part of the circuit before the blanking process, the polarity of the signal can be changed and thus pictures with black outlines on a white background may be produced as well (Fig. 8e). The fully transistorized equipment is constructed by means of plug-in boards, as shown in Fig. 13.

Possible Applications

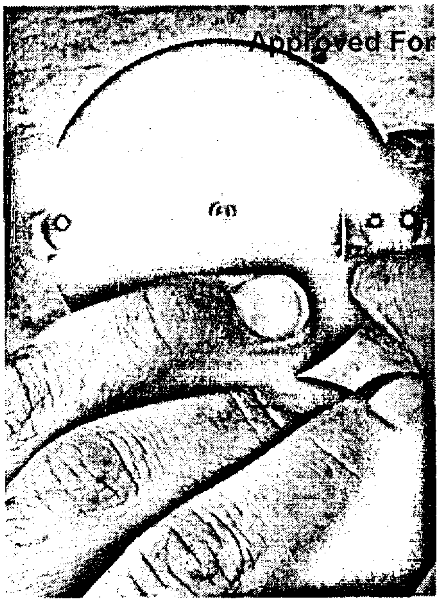
It is a special advantage of the method that slow lap-dissolves or moving wipe-fades between the original and the outline picture can be very simply effected. This has a very impressive visual effect that may, for example, introduce a flashback or illustrate some metamorphosis of persons or scenes. By means of a little variation of the circuit that is used for the differentiation in the horizontal direction, it is possible to make all the vertical outlines fade like an *e*-function. Thus an effect is produced that is shown in Fig. 14. In the example, it looks a little bit like moonlight.

A large number of further applications may be obtained by combining the outline signal with the signal of another picture source. The example of Fig. 15 was produced by masking the bottom right corner of the original slide showing the street by means of a gray foil with smooth density transitions, and blacking out this corner in the outline picture. A laboratory model of the equipment already has been used successfully in three TV productions.

Acknowledgments: The method of raster modulation has been developed by G. Högel together with A. Kaufmann and E. Vollenweider. The author wishes to thank them and especially H. Fix for his advice and encouragement. He is also grateful to E. Heinlein for his assistance in building the equipment for the electronic outliner. Finally, the author's thanks are due to Prof. Theile, the director of the IRT, for his kind permission to publish this article.

References

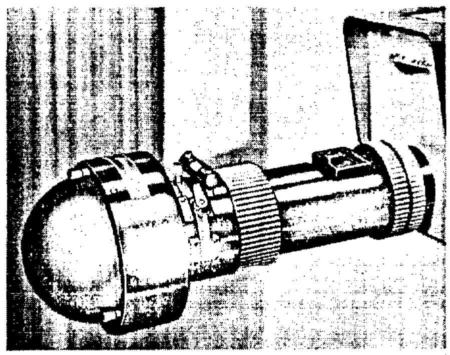
1. G. Högel and A. Kaufmann, "Die Erzeugung von rastermodulierten Fernsehbildern zur Anwendung in der Tricktechnik," *Rundfunktechnische Mitteilungen, 3:* 172–180, 1963.
2. G. Högel and E. Vollenweider, "Der Trickwandler — ein spezielles Gerät zur Rastermodulation von Fernsehbildern," to be published in *Rundfunktechnische Mitteilungen.*
3. U. Messerschmid, "Die Erzeugung von Umrissbildern beim Fernsehen durch Umformung des Videosignals," *Rundfunktechnische Mitteilungen, 3:* 160–171, 1963.
4. G. Högel, "Trickeffekte mit fernsehtechnischen Mitteln," *Kino-Technik,* No. 1, 1964.



and detector-amplifier selected for the wavelength interval of interest. Gratings, filters, spectral slits, and field stops are easily interchanged, as are the detector-amplifier modules, which are prefocused and self-aligning. When appropriate, these modules include cryogenic fittings for liquid-nitrogen transfer.

For more information, write: Electro-Optical Division, Perkin-Elmer Corp., Main Ave., Norwalk, Conn.

NEW PRECISION TESTER FOR TV CAMERA AND IMAGE TUBE



The Spectra TV Optoliner, Model 1000

Designed to test TV cameras and tubes, the Spectra TV Optoliner, Model 1000, threads into the lens mount of any Vidicon camera and enables the operator to check it for optomechanical alignment, sensitivity and full utilization of the scanning area, eliminating the many variables of an external test pattern check. Standard SMPTE, EIA and RETMA patterns are available. Accuracy of the mechanical alignment from the internal test pattern to the center of the lens mount is claimed as 0.002 in.

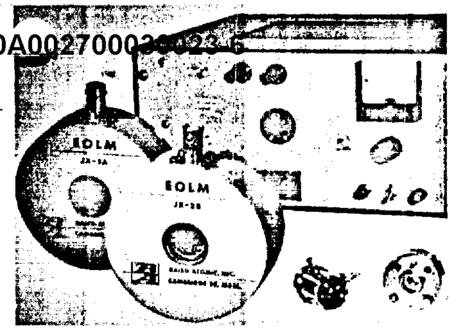
Regulated power supply and individually calibrated external meter makes the internal light levels and color temperature adjustable and reproducible. Accompanying test tools permit quick checks of tube centering and tilting. The camera unit weighs 3 lbs., is 11 in. long with maximum dia. of 4-3/4 in.

The Spectra TV Optoliner, Model 2000 for Image Orthicon Cameras, incorporates a movable slide test pattern to accommodate the wider tolerance of I. O. installations. Write for brochure to: *Photo Research Corp.*, 837 No. Cahuenga Blvd., Hollywood, Calif. 90038.

SOLID STATE Q-SWITCHER FOR LASERS

A new Q-Switcher system, utilizing a a Solid State Electro-Optic Light Modulator, has recently been announced by Baird-Atomic, Inc., Cambridge. Mass.

The new system is designed for use in giant pulse laser applications requiring switching times of less than ten nanoseconds. In addition to the large aperture, strain-free crystal Q-Switcher, the system also includes the associated electronics and precision mechanical adjustments and mounts.



Information and specifications on the Q-Switching system, as well as its complete line of Electro-Optic Light Modulators is available on request to Baird-Atomic, Inc., 33 University Rd., Cambridge 38, Mass.

"JR." VERSION OF HERMES

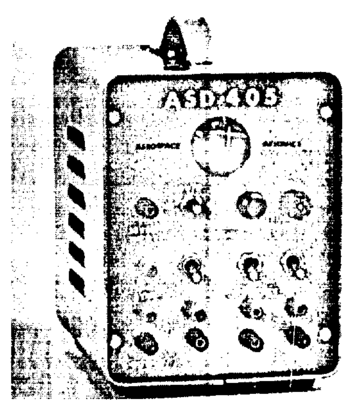
Itek Corporation announces a new version of the Hermes Precision Film Reader, the "Hermes Junior." The more compact model translates pictorial information into digital form.

Currently being produced by the corporation's Special Equipments Div., the film reader is specifically designed for precisely measuring the X and Y coordinates of nuclear tracks on spark or bubble chamber photographs, and converting this information into digital form.

The combined optical, mechanical, and electronic features of the Hermes Jr. are detailed in a new Technical Bulletin. The machine is offered as a basic reader to which optional special accessories can be added depending on customer needs.

Inquiries should be directed to the Special Equipments Div., Itek Corp., 223 Crescent St., Waltham, Mass.

SOLID SEQUENCING DEVICE



Model ASD 405 "15-150 Milliseconds"

The first solid sequencing device designed for applications requiring an automatic sequenced pulse for operation of relays, switches and three-phase motors is announced by Aerospace Avionics.

This unit, the Aerospace Automatic Sequencing Device, accepts input volt-

The picture looks better for closed-circuit television

High-resolution systems can be designed to transmit a wide range of data when engineers make the right tradeoffs

By F. Dan Meadows

Granger Associates, Palo Alto, Calif.

Inside a shut-down atomic reactor, a television camera moves slowly over every inch of the surface, searching for signs of deterioration. At a remote point, observers watch a monitor. As tiny cracks, fissures or other warning signs appear in sharp detail on the screen, they halt the camera and carefully examine the damage; then the search resumes.

Television systems are being used increasingly to transmit this kind of sensitive data. Such systems demand high-resolution capabilities that conventional television, adequate for home entertainment, cannot supply. Subjectively, a high-resolution tv image is defined as one that has photographic quality. Quality is further defined by three parameters: signal-to-noise ratio, tonal scale and picture sharpness. These factors, often mutually antagonistic, must be understood if the designer of a high-resolution tv system is to make intelligent tradeoffs.

Signal-to-noise ratio

Television noise is generated in several ways. Usually, random circuit noise is generated in the initial circuit stages and the noise power is proportional to the equivalent resistance, the video bandwidth, and the absolute temperature, following the general formula $E^2 = KTR(f_2 - f_1)$ where E represents the noise voltage, K is Boltzmann's constant, T the absolute temperature, R the source resistance, and f_1 and f_2 the lower and upper frequency limits in cycles per second, of the bandpass being considered.

This type of noise appears as "snow" or graininess in the picture. In a typical vidicon camera system, the vidicon load resistor determines the value of the initial signal and also makes a major contribution to the noise. The shunt capacitance of the vidicon circuitry and the input amplifier limit the high-frequency response. High-peaking circuits, added to compensate for the high-frequency rolloff at the vidicon output, will also boost high-frequency noise. It can be seen that the greater the signal current from the vidicon the lower the load resistor need be and the less high peaking is required. Thus, the signal-to-noise ratio is improved and wider bandwidths are more readily attained.

Hum pickup produces horizontal dark bars in the picture and often causes an "S" distortion along the vertical edges of the image. Most electrical interference shows up as horizontal streaks in the picture.

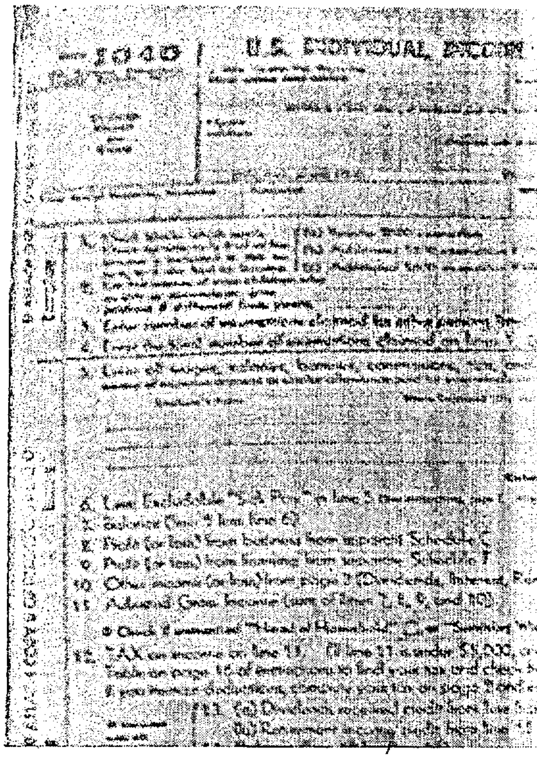
Noise may obscure picture information when its level approaches that of the signal. Fortunately, the eye integrates coherent (nonchanging) information in the picture and averages out much of the noncoherent noise. Signal-to-noise ratios which are discouragingly inadequate when measured on an oscilloscope, are often acceptable when viewed on the video monitor.

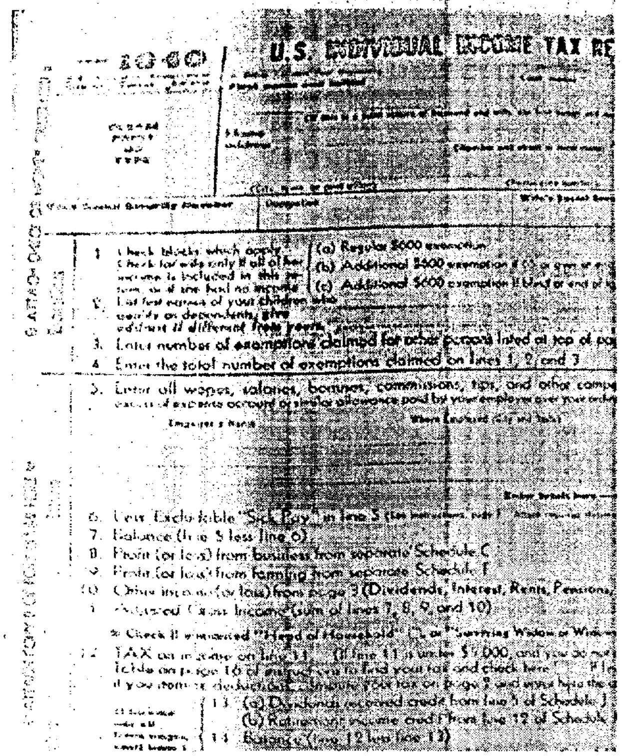
Dark current

Inadequate illumination of a scene forces the use of higher operating voltages on the camera tube

The author

F. Dan Meadows is manager of video products at Granger Associates. He has worked on video systems for over 20 years, with the Radio Corp. of America, Dage Electronics Corp., and the Ampex Corp. Meadows lists his spare-time interests as flying, golf, tennis, hi-fi and experimental electronics.



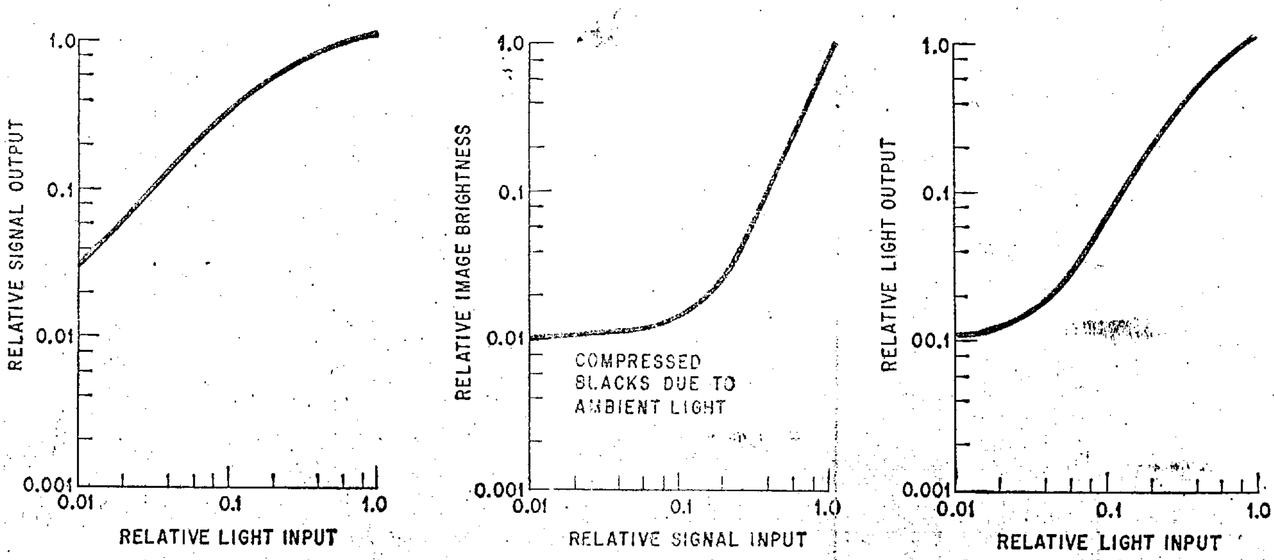


Blurred image of income tax form at the left is the way it's viewed on standard 525-line monitor—and by many taxpayers. Image at the right shows clarity possible with high-resolution 945-line television monitor.

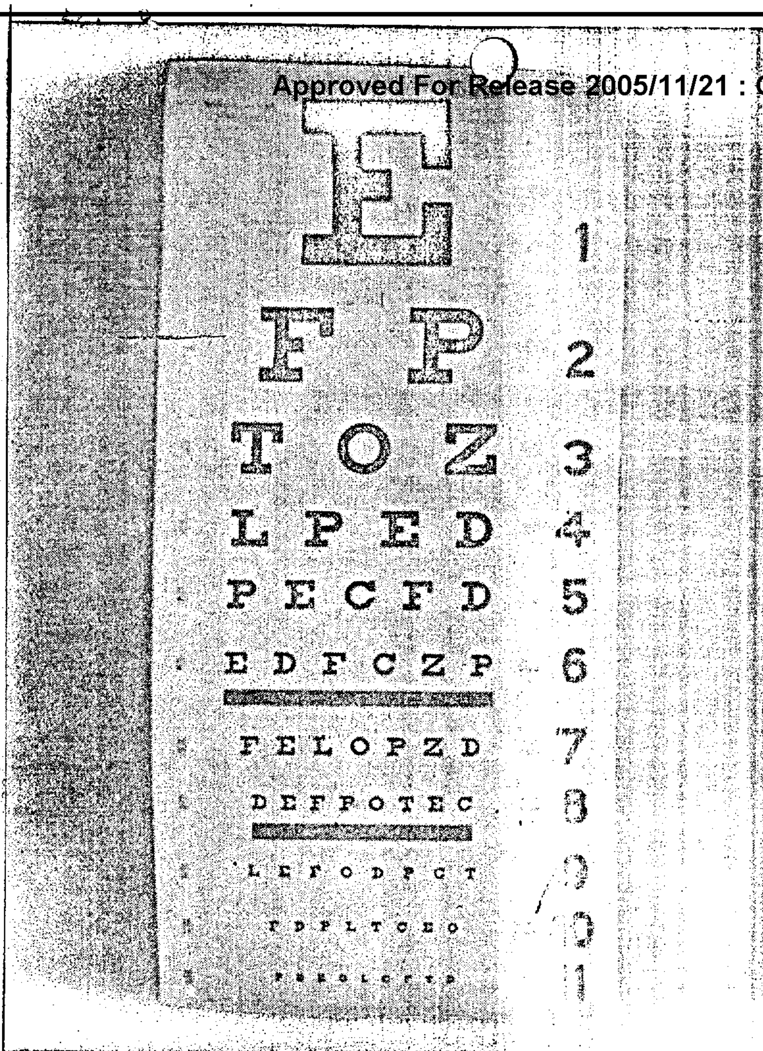
to provide more sensitivity. This, in turn, boosts the visible level of camera-tube anomalies such as nonuniform dark current and target surface irregularities. Dark current is the background current that flows through the camera tube even in the absence of light.

If the dark current is constant it does not affect the signal-to-noise ratio because the following amplifier is a-c coupled. However, nonuniformities during horizontal and vertical sweeps are transmitted through the system. Often these are reproduced as a dark ring around the outer edge of the picture, and are known as a "porthole" effect. Portholing can be caused by nonuniform deposition of the photosensitive material on the tube or by the scanning electron beam when it strikes the outer edges of the tube at an angle other than perpendicular. The signal output is proportional to the perpendicular component of the scanning beam, and because of the larger deflection angle, is smaller at the outer edges.

New vidicon types such as the 8507 have a sepa-



Linear system transfer characteristic (right), desirable for high resolution, is achieved by combining the ... (center).



Eye chart is displayed with almost photographic quality by a high-line-rate system with a 30-megacycle video bandwidth. Such systems are being used in banks, businesses and hospitals to transmit printed data.

rate mesh electrode which reduces the beam-landing error. In the case of the vidicon, the dark current increases more rapidly than the signal level (as the operating voltages are increased) and this ultimately limits the useful sensitivity of the tube.

A new vidicon tube, the Plumbicon, recently introduced by Philips Gloeilampenfabrieken, N.V., has a lead monoxide (PbO) surface instead of the usual antimony trisulfide (Sb_2S_3). Because of its very small dark current it can be used at low light levels that previously were more suited for the image orthicon than the vidicon.

A study of camera tube characteristics will indicate the minimum light level required for good signal-to-noise ratio and resolution.

Tonal scale

Tonal scale is the ability of the television system to reproduce faithfully varying shades of gray, from black to white, in the original scene. A good system can display 10 shades of gray over a brightness range of at least 30 to 1. "Black compression" or "white clipping" can occur when the camera pickup tube is not properly adjusted, if there's poor video circuit design, or as the result of maladjustment of the contrast control on the viewing screen. Another source of trouble is external illumination that hits the face of the picture tube and washes out the blacks in the picture. High-resolution viewing requires low ambient light levels because fine detail with low contrast may be lost in the ambient light reflections and scattering.

The transfer characteristic of a television system is the plot of light output versus light input. The "gamma" is the slope of the curve when plotted on log-log paper. The gamma of a typical camera tube compensates for the inverse characteristics of the kinescope display tube so that the net result is nearly a linear curve (gamma = 1). Adjustable gamma "correction" circuits are often added to the video chain to permit the tv system to reproduce film inputs with varying gamma characteristics. Gamma correction is also used to emphasize contrast when viewing x-ray images or transmitting printed data.

The illustration on page 71 shows that the transfer functions of camera and kinescope tubes can be combined to obtain a nearly linear curve.

Picture sharpness

Although it is a subjective parameter, picture sharpness is customarily measured by viewing a standard resolution "wedge" chart. But this is only part of the story; the eye is also sensitive to the contrast between images and even if a picture has relatively poor limiting resolution, high contrast will make it seem sharp.

The concept of detail response is important to the proper evaluation of tv systems. A typical detail response curve is similar to the response curve of a high-fidelity audio system. As the electron beam in the camera pickup tube scans the optical image it generates video signals with frequencies proportional to the number of picture elements. The more detail in the picture, the higher are the generated frequencies. The amplitude of the signal decreases with the output frequency for many reasons. Among them are:

- The finite size of the scanning beam (aperture) of both the camera tube and the kinescope display tube.
- Bandwidth limitations which tend to round off what should be square waves
- Limitations of the camera lens
- Limitations of the human eye which cannot distinguish between separate images less than approximately one minute of arc (1/60°) apart.

A detail response curve shows the relative signal output resulting from scanning vertical black and white lines on a test chart. The horizontal line number is the number of vertical black and white lines in a horizontal dimension equal to the picture height. The 100% reference level is the signal resulting from a half black-half white pattern. As more lines are scanned, the generated video fre-

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quency increases and the signal output level rolls off ultimately to the point where the signal is lost in the noise. The 10% response point is usually considered the limit of useful resolution. The graph at the right shows the detail response curves of the various elements of a tv system and the response curve of the combined system.

Surprisingly, even a good lens has substantial fall-off at the higher line numbers and contributes substantially to the loss in resolution in a high resolution tv system.

The effect of "aperture" or cross-section of the scanning electron beam in the camera tube is shown in the lower graph at the right. The curve demonstrates the improvement due to increases in the focus field surrounding the tube. An increase from a 40-gauss to a 70-gauss focus field increases the signal output from 40% to 55% at 1,500 lines. This results from the tighter packing of the electron beam and the subsequent smaller scanning spot. In order to maintain one spiral loop as the beam travels down the vidicon tube, the accelerating voltage must be increased as the focus field is increased.

It has been shown that subjective sharpness can be specified by the term N_e which is the equivalent passband of the system element being evaluated. N_e is simply a rectangle whose area is the same as that under the squared detail response curve. In other words, regardless of the limiting resolution as viewed from the test pattern, systems with the same area under the squared response curve have the same subjective sharpness. Even the eye has an N_e whose value varies with illumination and distance from the kinescope.

The over-all system response at any line number is the product of the individual component responses at that line number and the system N_e can be found by the following formula:

$$N_e = \sqrt{\frac{1}{\left(\frac{1}{N_{e1}}\right)^2 + \left(\frac{1}{N_{e2}}\right)^2 + }}$$

The N_e for typical components and the total system is:

Camera lens	940
Camera tube	200
Kinescope	350
Total system	170

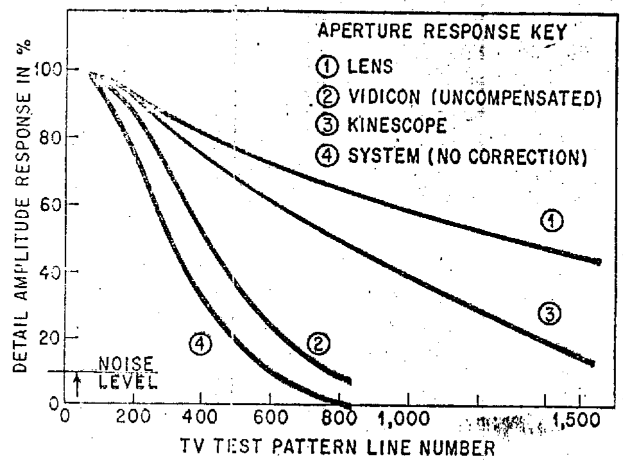
Substantial improvement in system sharpness can be obtained by introducing a compensating high-frequency boost (aperture correction) in the video amplifier. The boost must be at the frequencies and magnitude that will not boost objectionable noise levels along the signal.

Scan lines

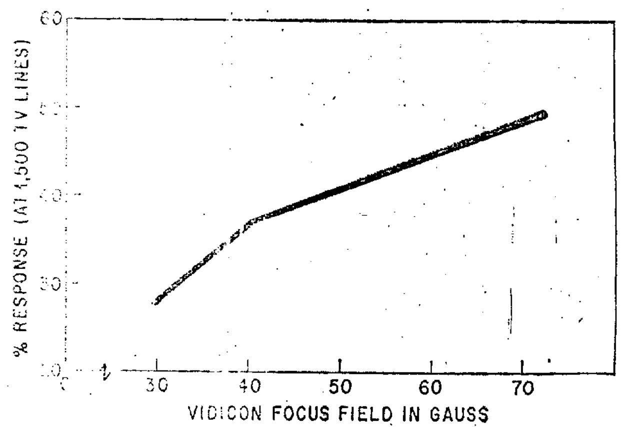
The discussion thus far applies primarily to sharpness in the horizontal direction. Vertical resolution is determined largely by the number of scanning lines. Vertical resolution can be measured by viewing the horizontal wedges on a test pattern. The point where they merge indicates the line number of limiting vertical resolution. This number is approximately 0.7 of the number of scanning lines. The 0.7-figure is known as the Kell factor.

All of the video signal is generated along the scan lines and no information is produced from the space between the lines. To increase the amount of detail in the vertical dimension, more scan lines are needed.

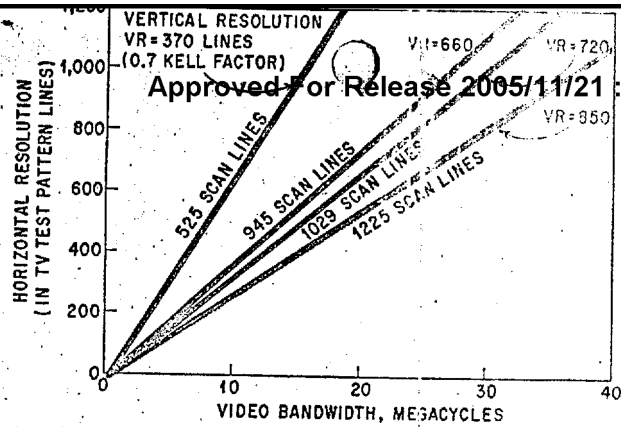
For commercial broadcast tv service the number of scanning lines is fixed by the governments of the various countries. The United States standard is 525; in England it is 405; for France the number is 819, and so on. Since closed-circuit tv is not government regulated, the scan rate becomes a matter of design choice. Systems with scanning rates up to 1,225 lines are available off the shelf. For good video transmission of alphanumeric data at least 7, and preferably 10, scan lines should pass through each character. Thus a 525-line system would require character sizes 2% of the picture



Response to detail of the components of a television system, measured in terms of test pattern lines. Unless compensated, each component contributes to system degradation as resolution capability is increasingly taxed.



Reducing the beam cross-section in a vidicon tube by increasing the tube's magnetic focusing field can improve the camera's resolution significantly.



For a given number of lines in the display raster, video bandwidth must be increased to achieve higher horizontal resolution. The Kell factor referred to relates the number of scan lines to vertical resolution of the system.

height. A 1,029-line system can reproduce characters whose size is only 1% of the picture height, making it possible to view twice as much data with a 1,029-line system as with a 525 line system.

Unfortunately, the designer's job means more than just doubling the sweep frequency in order to get twice as many scan lines. Doubling of the number of lines in the same frame time (usually 1/30 second) requires doubling the linear velocity of the scanning beam. The available signal pulse rise time is now halved and unless the bandwidth of the system is increased in proportion to the increase in number of scan lines, the horizontal resolution suffers in exact proportion to the increase in vertical resolution.

A good 525-line tv system with a 10-megacycle bandwidth can reproduce one-half a typewritten page, 8-½ × 11 inches, with satisfactory results. However, it cannot reproduce a full page satisfactorily. The task becomes even more difficult if the data is of random nature, such as alphanumeric output from a computer, because the mind cannot fill in missing information. On the other hand, a high-line-rate system with a 30-Mc video bandwidth can produce an image of almost photographic clarity.

Broader use

Some typical applications of high-resolution tv capabilities include its use in commercial establishments to transmit printed data from floor to floor using a very simple transmitting console and a camera suspended above an illuminated table. The copy is placed on the table in a predetermined position and the image is sent to various viewing locations throughout the building, eliminating the need for messengers to deliver copy from file locations to the user.

Large hospitals file patient's medical records in a basement area and transmit the data via closed-circuit television to various viewing areas throughout the hospital.

Very sophisticated television display systems are in use at the Manned Spacecraft Center in Houston at the North American Air Defense Command in Colorado Springs, at the Satellite Test Center in Sunnyvale, Calif., and at the Jet Propulsion Laboratory in Pasadena, Calif. Multiple camera and viewing positions permit personnel to have immediate access to information posted on situation display boards in other areas; to switch to selected Teletype images; to view maps of geographical areas and weather conditions; and to view the printed output of computers. Fingertip controls permit the selection of as many as 200 sources of data at one viewing console in a fraction of a second.

High-resolution tv equipment is being used to investigate matter through high-powered microscopes. One system at the University of California Radiation Laboratories views tracks left by the disintegration of atomic particles through a film emulsion. The video output is processed and fed into a computer which analyzes six different sets of data for each track. Track information, less than one micron in size, is analyzed by the tv system through a microscope with a magnification of 2500X. A similar technique is used by a British manufacturer in metallurgical applications to measure inclusions, volume fraction, grain size, and size distribution.

The Picker X-Ray Corp. of Cleveland offers a very-high-resolution tv system that uses an x-ray-sensitive vidicon tube to examine small components such as transistors, diodes, capacitors, relays, for minute flaws. A solder ball only 0.006 inch in diameter has been detected inside a TO-5 transistor housing.

Another company, the Rucker Manufacturing Co. of Oakland, Calif., is constructing a large centrifuge which will mount a high-resolution tv camera to observe the effects of 100-g acceleration on sample objects. The photographic quality of the image will permit the discovery of very small distortions which would be undetectable with tv systems of conventional design.

The Federal Aviation Agency has tested systems for use at airports to observe taxiing aircraft that are out of view of the controller in the tower. High-resolution tv systems permit the reading of identification numbers on aircraft at distances that are twice the capability of conventional tv systems. A tradeoff for such an application would be the use of a wide-angle lens that would permit four times the area of view with the same resolution as could be obtained by a conventional system with one-fourth of that field of view.

In one military application, the use of high-resolution tv cameras on radar dishes permits visual observation of missiles at limiting ranges more than twice that possible through the use of conventional television designs.

Reference

1. "Image Gradation, Graininess and Sharpness in Television and Motion Picture Systems," Journal S.M.P.T.E., August, 1953.

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